CLAIMS

What is clamed is:

1. A composition comprising a polyethylene wherein the composition is enriched in polymer molecules having topological variations by an enrichment factor ω and wherein the composition displays a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms.

2. The composition of claim 1 wherein the polyethylene is a Ziegler-catalyzed polyethylene.

3. The composition of claim 1 wherein ω is greater than about 2.

4. A composition comprising an isolated Ziegler-catalyzed polyethylene having a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms at the high molecular weight end.

5. The composition of claim 4 wherein the isolated Ziegler-catalyzed polyethylene has a radius of gyration less than that of a linear polymer of the same weight average molecular weight.

6. The composition of claim 4 wherein the isolated Ziegler-catalyzed polyethylene has a radius of gyration of from about 35 nm to about 75 nm at a weight average molecular weight of 5 x 10^6 g/mol and from about 45 nm to about 110 nm at a weight average molecular weight of about 1 X 10^7 g/mol.

7. An isolated topologically-varied polyethylene homopolymer having a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon wherein the homopolymer is isolated from a Ziegler-catalyzed polyethylene homopolymer by solvent-gradient fractionation and where the radius of gyration of the topologically-varied homopolymer is less than that of a linear polymer of identical molecular weight.

8. The topologically-varied polyethylene homopolymer of claim 7 having a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

9. The topologically-varied polyethylene homopolymer of claim 7 having a zero shear viscosity that ranges from about 5.0E+02 Pa-s to about 1.0E+07 Pa-s.

10. The topologically-varied polyethylene homopolymer of claim 7 having a zero shear viscosity that is from about 20% to about 500 times smaller than an otherwise similar linear polymer of the same molecular weight.

11. The topologically-varied polyethylene homopolymer of claim 7 having a density of from about 0.90 g/cc to about 0.965 g/cc.

12. The topologically-varied polyethylene homopolymer of claim 7 having a weight average molecular weight of from about 50 kg/mol to about 2,000 kg/mol.

13. The topologically-varied polyethylene homopolymer of claim 7 having a CY-a parameter of from about 0.05 to about 0.70.

14. The topologically-varied polyethylene homopolymer of claim 7 having a polydispersity index of from about 3 to about 100.

15. The topologically-varied polyethylene homopolymer of claim 7 wherein the topologically-varied polyethylene homopolymer is present in the Ziegler-Natta polyethylene homopolymer in an amount of from about 0.1 wt% to about 30 wt%.

16. The topologically-varied polyethylene homopolymer of claim 7 wherein a van Gurp-Palmen (vG-P) plot of loss angle against the corresponding magnitude of the complex shear modulus, |G*|, plateaus at angles less than about 90° and decreases as the complex shear modulus, |G*|, decreases.

17. A method comprising:

contacting a Ziegler-catalyst with an ethylene monomer under conditions suitable for the formation of an ethylene polymer;

recovering an ethylene polymer;

fractionating the ethylene polymer into polymer fractions by solvent gradient fractionation;

identifying topologically-varied ethylene polymer fractions having radius of gyration values less than that of a linear polymer of an identical weight average molecular weight; and

recovering the polymer fractions having radius of gyration values less than that of a linear polymer of the identical weight average molecular weight.

18. The method of claim 17 wherein the polymer fractions having radius of gyration values less than that of a linear polymer of the same weight average molecular weight have a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms.

19. The method of claim 17 wherein the polymer fractions having radius of gyration values less than that of a linear polymer of the same weight average molecular weight have a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

20. The method of claim 17 wherein the polymer fractions having radius of gyration values less than that of a linear polymer of the same weight average molecular weight have a zero shear viscosity ranging from about 5.0E+02 Pa-s to about 1.0E+07 Pa-s.

21. The method of claim 17 further comprising modifying the polymer fractions having radius of gyration values less than that of a linear polymer of the identical weight average molecular weight.

22. The method of claim 21 wherein modifying comprises oxidation, surface modification, corona treatment, plasma treatment, photochemical treatment, chemical treatment chemical grafting, end-capping with short chains or organic molecules, terminal grafting via living polymerization, blending with other polymer components, crosslinking of the polymer chains or combinations thereof.

23. A topologically varied ethylene polymer fraction produced by the method of claim 17.

24. A fluid flow modifier comprising the topologically varied ethylene polymer of claim 23.

25. A method for the production of topologically-varied polyolefins comprising contacting a Ziegler catalyst in the presence of a polar aprotic solvent with an olefin under conditions suitable for the production of a polyolefin wherein the polyolefins produced in the presence of the polar aprotic solvent have an increased amount of topologically varied polyolefins when compared to the a polyolefin produced under control conditions in the absence of a polar aprotic solvent.

26. The polyolefin produced according to claim 25.

27. A method comprising:

contacting an olefin monomer with a catalyst under a first set of conditions suitable for the formation of a first olefin polymer wherein the first olefin polymer comprises an amount (x) of topologically-varied olefin polymer molecules;

adjusting the first set of conditions to produce a second set of conditions; and

contacting an olefin monomer with a catalyst under the second set of conditions suitable for the formation of a second olefin polymer wherein the second olefin polymer comprises an amount (y) of topologically-varied olefin polymer molecules, wherein y is

greater than x and wherein the second set of conditions comprises an apolar protic solvent.

CLAIMS

What is claimed is:

1. A composition comprising a polyethylene wherein the composition is enriched in polymer molecules having topological variations by an enrichment factor ω, wherein ω is greater than about 2, and wherein the composition displays a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms, wherein the topological variations comprise long chain branching, wherein the enrichment factor ω is determined using a Ziegler-catalyzed polymer as the source polymer, and wherein the composition displays a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

2. A composition comprising an isolated Ziegler-catalyzed polyethylene having a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms and displays a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

3. The composition of claim 2 wherein the isolated Ziegler-catalyzed polyethylene has a radius of gyration less than that of a linear polymer of the same weight average molecular weight.

4. The composition of claim 2 wherein the isolated Ziegler-catalyzed polyethylene has a radius of gyration of from about 35 nm to about 75 nm at a weight average molecular weight of 5×10^6 g/mol and from about 45 nm to about 110 nm at a weight average molecular weight of about 1×10^7 g/mol.

5. An isolated topologically-varied polyethylene homopolymer having a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon wherein the homopolymer is isolated from a Ziegler-catalyzed polyethylene homopolymer by solvent-gradient fractionation, wherein the radius of gyration of the topologically-varied homopolymer is less than that of a linear polymer of identical weight average molecular weight, and wherein the topological variation comprises long chain branching.

6. The topologically-varied polyethylene homopolymer of claim 5 having a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

7. The topologically-varied polyethylene homopolymer of claim 5 having a zero shear viscosity that ranges from about 5.0E+02 Pa-s to about 1.0E+07 Pa-s.

8. The topologically-varied polyethylene homopolymer of claim 5 having a zero shear viscosity that is from about 20% to about 500 times smaller than an otherwise similar linear polymer of the same molecular weight.

9. The topologically-varied polyethylene homopolymer of claim 5 having a density of from about 0.90 g/cc to about 0.965 g/cc.

10. The topologically-varied polyethylene homopolymer of claim 5having a weight average molecular weight of from about 50 kg/mol to about 2,000 kg/mol.

11. The topologically-varied polyethylene homopolymer of claim 5 having a CY-a parameter of from about 0.05 to about 0.70.

12. The topologically-varied polyethylene homopolymer of claim 5 having a polydispersity index of from about 3 to about 100.

13. The topologically-varied polyethylene homopolymer of claim 5 wherein the topologically-varied polyethylene homopolymer is present in the Ziegler-Natta polyethylene homopolymer in an amount of from about 0.1 wt % to about 30 wt %.

14. The topologically-varied polyethylene homopolymer of claim 5 wherein a van Gurp-Palmen (vG-P) plot of loss angle against the corresponding magnitude of the complex shear modulus, |G*|, plateaus at angles less than about 90° and decreases as the complex shear modulus, |G*|, decreases.

15. A method comprising:
contacting a Ziegler-catalyst with an ethylene monomer under conditions suitable for the formation of an ethylene polymer;

recovering an ethylene polymer;

fractionating the ethylene polymer into polymer fractions by solvent gradient fractionation;

identifying topologically-varied ethylene polymer fractions having radius of gyration values less than that of a linear polymer of an identical weight average molecular weight; and

recovering the polymer fractions having radius of gyration values less than that of a linear polymer of the identical weight average molecular weight and wherein the polymer fractions display a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

16. The method of claim 15 wherein the polymer fractions having radius of gyration values less than that of a linear polymer of the same weight average molecular weight have a long chain branching frequency of greater than about 0.5 long chain branches per 1000 total carbon atoms.

17. The method of claim 15 wherein the polymer fractions having radius of gyration values less than that of a linear polymer of the same weight average molecular weight have a zero shear viscosity ranging from about 5.0E+02 Pa-s to about 1.0E+07 Pa-s.

18. The method of claim 15 further comprising modifying the polymer fractions having radius of gyration values less than that of a linear polymer of the identical weight average molecular weight.

19. The method of claim 18 wherein modifying comprises oxidation, surface modification, corona treatment, plasma treatment, photochemical treatment, chemical treatment, chemical grafting, end-capping with short chains or organic molecules, terminal grafting via living polymerization, blending with other polymer components, crosslinking of the polymer chains or combinations thereof.

20. A topologically varied ethylene polymer fraction produced by the method of claim 15 wherein the topological variations comprise long chain branching.

21. A fluid flow modifier comprising the topologically varied ethylene polymer of claim 20.

22. A method for the production of topologically-varied polyolefins comprising contacting

a Ziegler catalyst in the presence of a polar aprotic solvent with an olefin under conditions suitable for the production of a polyolefin wherein the polyolefins produced in the presence of the polar aprotic solvent have an increased amount of topologically varied polyolefins when compared to the polyolefin produced under control conditions in the absence of a polar aprotic solvent, wherein the topological variations comprise long chain branching, and wherein the composition displays a zero shear viscosity that negatively deviates from the Arnett 3.4 power line law.

23. The polyolefin produced according to claim 22.